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| | ASSESSMENT OF ANTHROPOGENIC ACTIVITIES, ENVIRONMENTAL LITERACY AND MANAGEMENT PRACTICES IMPACTING LAKE BOSOMTWE |
| Volume: 3 Number: 1 Page: xxx - xxx | Godfred OWUSU-BOATENG¹, Thomas Kwaku AGYEMANG², Akwasi AMPOFO-YEBOAH³, Kofi SARPONG⁴ ^{1,2} Faculty of Renewable Natural Resources, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana. ³ Department of Fisheries and Aquatic Resources Management, University for Development Studies, Tamale, Ghana. ⁴ Faculty of Science and Environment Education, University of Education, Winneba, Asante-Mampong, Ghana. Corresponding author: Godfred Owusu-Boateng E-mail: goboateng.irnr@knust.edu.gh |
| Article History: Received: 2021-10-25 Revised: 2021-11-15 Accepted: 2021-11-18 | Abstract: The communities in the Bosomtwe basin depend on Lake Bosomtwe for their livelihoods. However, the lake has continued to experience human-driven degradation in recent times. We conducted a survey of the main anthropogenic perturbations of the lake, the level of awareness of the communities of anthropogenic interventions and their effects on lake health, and the effectiveness of its management practices using a structured questionnaire administered to 350 respondents. Data were analyzed using non-parametric Kruskal Wallis and Mann Whitney U-tests. Crop farming, fishing, fish mongering, animal rearing, timber harvesting, hospitality operations, washing, other trades, and illegal mining were the anthropogenic interventions of the most devastating consequence, promoted by a low level of education and environmental awareness. Although the regards for directives of the traditional authority to govern the lake declined subtly, the situation is worsening due to inadequate resources for the Bosomtwe District Assembly, the government agency responsible for coordinating the activities of stakeholders of the lake and providing an effective decision-making basis for its conservation. The results, which have direct practical implications for water management, suggest the need for well-coordinated policies and strategies for law enforcement and education of basin communities on the causes and effects of lake degradation. Keywords: Lake, degradation, anthropogenic, survey, education |
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INTRODUCTION

The globe is faced with a serious challenge in the bid to equilibrate environmental conservation and socio-economic development (White and Hunter, 2009; Wu et al., 2020). The interface between socioeconomic development and resource conservation has been difficult to build. This challenge is a function of education on resource infiniteness and behavioral change.

Availability of good quality water on a sustainable level is necessary for disease prevention and social stability (Van Vuuren, 2013). However, anthropogenic factors for economic growth, demographics, and climate change cause extensive degradation in many parts of the world. For sustainability, an effort to reverse the phenomenon is essential. Protection of aquatic systems is crucial if life on the planet

can be sustained. In response to the survival needs of the ever-growing global population, the water used has become a critical environmental commodity that needs to be carefully considered (Oki and Quioco, 2020). In the present circumstance, the tendency is for people, in their critical need of domestic water, to resort to using all kinds of water and in all states that they lay hands on. The only factor to consider has, in most cases, been 'availability' (Bluma, 2020). It has both direct and indirect serious health implications on individuals in particular and society in general, since such developments negate their contribution and negatively affect socio-economic development.

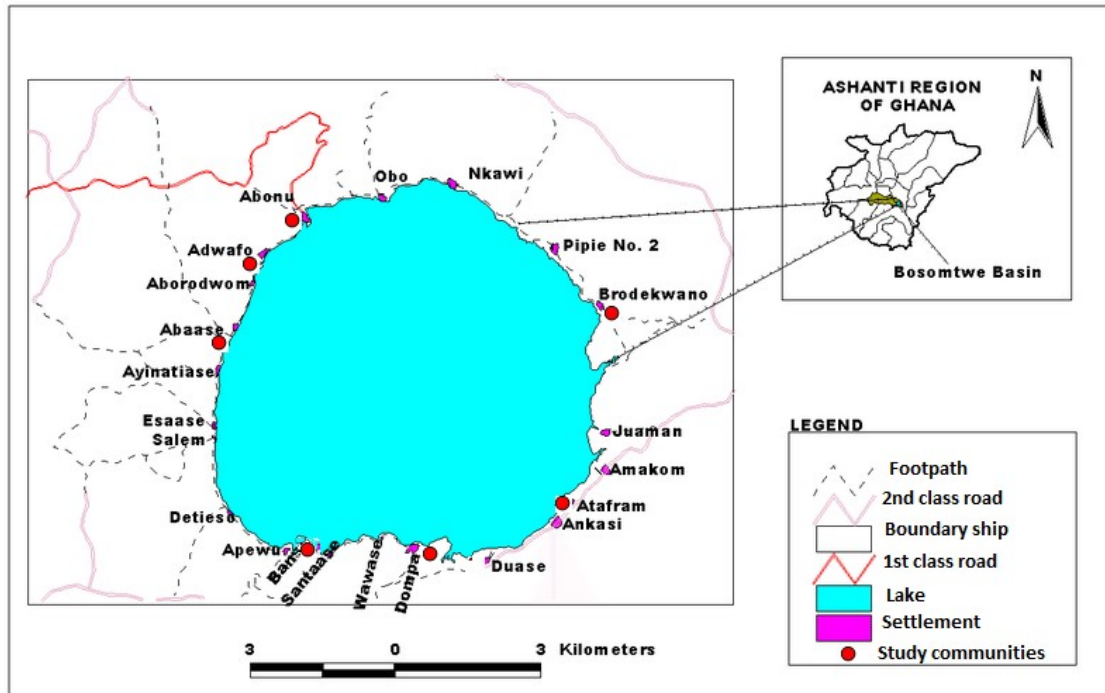
Proper environmental protection behavior of communities in the vicinity of water bodies is one of the measures that are believed to promote this global desire for sustainability. Educational activities are known to be significant in approaches directed to permanent solutions for environmental problems (Safari and Zahraghasemi, 2014). Education of individuals on awareness of their surroundings and environmental consciousness can be considered an effective way of dealing with these problems. Instructing individuals may not help to the goal of conservation, but inform them about the effect of their actions (Ata, 2018) on the benefits of the environment and hence the need for positive attitudes towards the environment.

It has been presumed that lack of development and understanding is the underlying cause of the degradation of the lake. To close this gap of presumption, we undertake this social survey to solicit the views of communities on the understanding and perception of communities of the regeneration capacity of the Lake Bosomtwe. Shaughnessy et al. (2011) noted that a social survey enables the target group's thoughts, opinions, and feelings to be evaluated. Exploring such perception, which is crucial in policymaking, is the goal of this paper.

METHODS

The Bosomtwe District, inhabited by about 70000, is located near the center of the Ashanti Region, covering about 718km². Formed over one million years ago as crater lakes, the lake is situated in the Bosumtwi meteorite impact crater, which describes a circular depression of radius of about 5.25 km. Limnologists have given accounts of some of the physical dimensions of the lake itself: a hydrologically closed basin (Figure 3.1) with diameter and depth of 8 km and 78 m, respectively (Whyte, 1975). It covers an area of approximately 48.6 km² (Turner et al., 1996). The lake, lying in a rocky depression (Abban, 1988), has a blend of forest and wetland ecosystems within which a wide spectrum of flora and fauna reside, including the endemic tilapia species *T. busumanna*.

Figure 1. A Map Of Lake Bosomtwe And Its Catchment Area



The area was characterized by low development of infrastructure and social amenities. Although a few residents in the communities in the catchment speak the English language, Akan is the main language spoken. Residents uphold cultural values and are subjects of governance by indigenous chiefs. Several sacred sites exist in communities around the lake. Seven (7) of the basin communities, namely; Abono, Adwafo, Abaase, Benso, Atafra, Dampa and Old Brodekwan (Figure 3.2), along the lake that depends on the lake for their livelihood, were selected for the study. In selecting the communities, factors including the following were noted before community engagements: location of the communities, ease of accessibility of the communities, level of the corporation of the communities, and the possibility of livelihood activities relating to the health of the lake.

Both structured and semi-structured and interviews of contextual relevance were used to ensure that the data collected is associated with limited assumptions (Bhattacharjee, 2012) and focus group discussions were used to obtain information on the causes and effects of degradation of the lake and the practices adopted for management and protection of the lake by key stakeholders. Where appropriate and possible, personal observations were also employed to verify the responses' validity. Therefore, emphasis was laid on the socio-cultural context. The questionnaire was administered to a sample (n) of 350 people from the total number of households (N) at a margin of error (e) of 5% according to the relation $n = N/(1 + N(e^2))$ in conforming to (Gomez and Paul 2010). While some of the areas were easily accessible, others were not. Therefore, assistance was sought from some community members who operate wooden planks variously described in the local parlance as 'Padua' and 'Ponkor' for a fee (GH¢ 30 per day) for the trips to access the designated areas.

According to Pandey (2004), some traditional knowledge has proven to be efficient in resource conservation. For this reason, the opportunity of local communities to share their knowledge on how the lake and its resources have been impacted was also explored. The participatory Rural Appraisal (PRA) was also adopted to enrich the information gathered and identify any outliers that could not be a

reflection of the true situation. The Participatory Rural Appraisal approach was used to gather information on social variables such as observation of buffer zones, forbidden and taboos days, sacred grooves and bye-laws (Mascarenhas et al., 2003). It was to ensure that the strength of the technique, which considers the inclusion of local people in planning, implementation, and management of the lake and its resources, is explored. While the benefits of localization, inclusiveness, empowerment, and respect in using the PRA were explored, the associated drawbacks such as hijacking, formalism, and disappointments were kept in mind.

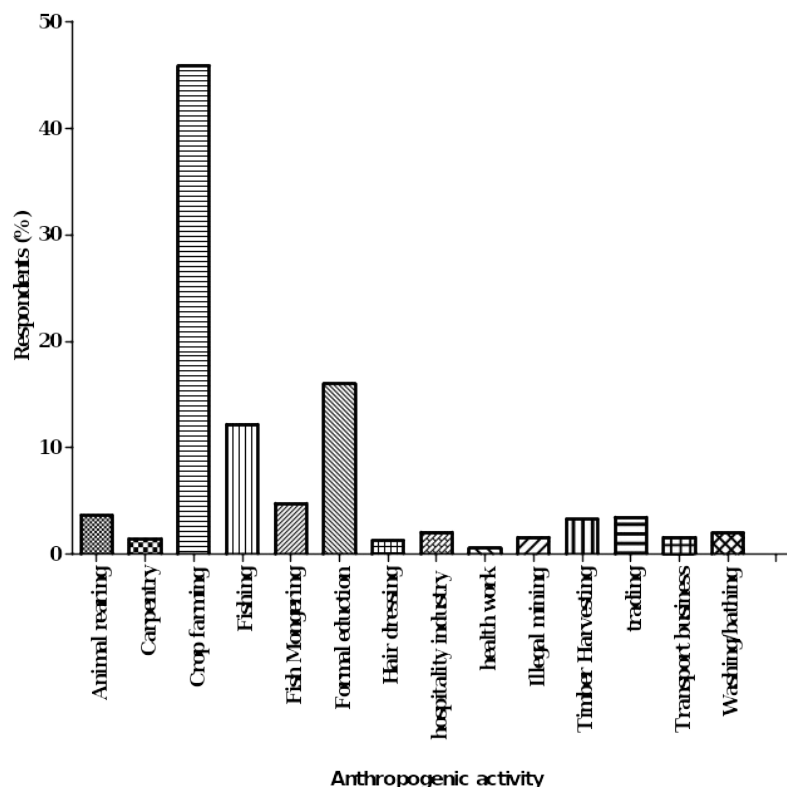
The responses to these questions) were organized and analyzed using statistical software (Statistical Package for Social Sciences (Version 20) and GraphPad Prism (Version 5.01). Results were displayed in tables, graphs and charts, and trends and observations interpreted and explained to form the basis on which recommendations for conservation considerations were made. The relative prevalence of major anthropogenic activities, the possible impact and Rank (sum of prevalence and impact) in the Lake Bosomtwe catchment were determined.

RESULT AND DISCUSSION

Anthropogenic activities impacting the Lake Bosomtwe

Results indicate that the main anthropogenic activities that occur in the study communities in the lake basin are animal rearing, carpentry, crop farming, fishing, fish mongering, formal education, hairdressing, hospitality operation, health work, illegal mining (commonly referred to as 'galamsey'), timber harvesting, transport business and washing dishes, clothes and vehicles. These anthropogenic activities occurred at varying proportions, the most dominant among them crop farming (44.2%), followed by formal education (16.0%) and fishing (14.0%) (Figure 1).

Figure 2. Distribution of anthropogenic activities in the Lake Bosomtwe Basin



The dominance of crop farming may result from the availability of land, traditional inheritance, and limitation of options (Bjornlund et al., 2020). The significance of formal education, which ranked second among anthropogenic

activities, is expected, as the school itself provides employment (Cervone, 2017). According to Lyson (2002), the small rural school serves as an important marker of social and economic viability and vitality.

Dominant anthropogenic activities

In order of decreasing devastation among the identified anthropogenic activities that affected the lake directly, the activities may be arranged as crop farming (62.6%), fishing (14.4%), fish mongering (5.7%), animal rearing (4.4%), timber harvesting (3.9%), hospitality industry operations (3.2), vehicles, clothes and dishes and bathing (3.1%), Other trades (2.7%), washing and illegal mining commonly known as 'galamsey' (1.4%) (Figure 2). Therefore, the emergence of crop farming as the most devastating anthropogenic effect on the lake is not surprising, as it is the dormant livelihood among the studied communities (Stein, 2021).

In time past, fishing was the dominant activity for livelihoods of the communities in the catchment of Lake Bosomtwe, but with time, as the stock of fish continues to stretch towards depletion, communities have resorted to farming as the major occupation (Watson and Pauly, 2001) with a high inclination to stock depletion. The socioeconomic cost of overfishing (Somma, 2003) in the lake. It involves harvesting under-sized fish pollution, disease infestation, greater fishing effort, and the use of unapproved fishing gear and fishing technology which have thrown fishers and fishmongers out of the fishing business. These may be promoted by high customer patronage (Saltelli et al., 2000). The drift of most fishers into farming may increase the production of food crops in the catchment communities and beyond for increased income. However, the possibility of accelerated deterioration of the lake water quality also exists, given the current poor farming practices adopted by the communities (Baruwa et al., 2011).

Crop farming (Plate 1), animal rearing, fishing, fish mongering, hospitality industry management, illegal mining and washing (Plate 2) affect the lake directly while carpentry, hairdressing, health work and formal education do not. For example, carpentry affects the lake indirectly because the wooden plank 'Ponkor' or 'Padua' that is used for fishing and transport on the lake is a carpentry handicraft. Boat operations have been reported to be banned on the lake due to the devastating effect of noise that it produces (Popper, 2009), which is believed to disturb the 'children' of the lake hence, the use of 'Ponkor'.



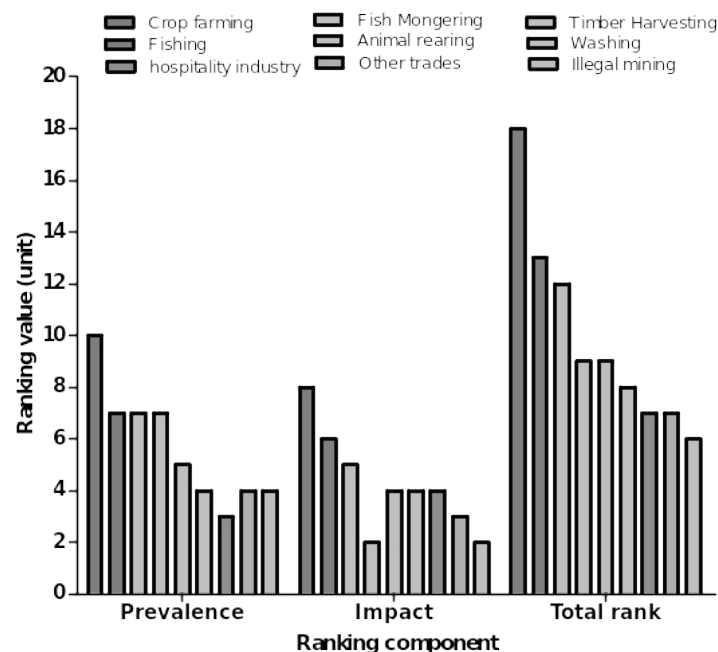
Plate 1: A farm cited at the banks of the Lake Bosomtwe at Domba being dried



Plate 2: Fishing nets and clothes at the bank of the Lake Adwafo

Again, schoolchildren were sometimes organized and sent to the lake for lessons on environmental education by non-governmental organizations and schools in the communities. It aims to expose school children to sound environmental practices and inculcate the habit of harmonious existence with nature in them (UNESCO, 2008).

Figure 3. Ranking of major anthropogenic activities in Lake Bosomtwe catchment



Communities-related impacts

Generally, the major anthropogenic impacts were highlighted more at Abono, the most populous among the community. With Abono as the reference point, a general trend emerged; fishing and Fish mongering and hospitality operations appeared to increase at the expense of farming activities. The strategic position may account for the Abono's observation in the basin. The relatively improved road networks leading from Kumasi, with other social amenities such as electricity, make the community the most accessible community, open to tourism and businesses, promoting visits to the lake (DFID, 2002). These observations are also supported by Warr (2010) and Runsinarith (2011), who recounted that Good road networks and electricity are among the amenities that promote business operations, improving income, farming systems, living standards and poverty reduction (Dercon, 2004).

Understanding of communities on the causes and effects of water quality degradation

Understanding the communities' demography helps explain the anthropogenic activities in the lake basin. The characteristics considered were gender, age, marital status, occupation, length of years of stay in the community, length of years of stay in the occupation and education (Table 1).

Table 1. Distribution Of Demographic Characteristics Of Communities In Lake Bosomtwe Basin

| Demographic Variable | Characteristics | Number (n = 350) | % |
|----------------------|-----------------|------------------|------|
| Gender | Male | 205 | 58.6 |
| | Female | 145 | 41.4 |
| Age Group (years) | 18 | 25 | 7.14 |
| | 19 - 30 | 44 | 12.7 |
| | 31 - 40 | 88 | 25.0 |
| | 41 - 50 | 79 | 22.6 |
| | 51 - 60 | 58 | 16.6 |
| | > 60 | 56 | 15.9 |
| | Single | 56 | 15.9 |
| | Married | 211 | 60.3 |

| | | | |
|---------------------------------------|------------------------|-----|------|
| Marital Status | Divorced | 28 | 7.94 |
| | Widowed | 56 | 15.9 |
| No. of years of stay in the community | 1 -10 | 36 | 10.3 |
| | 11 - 20 | 35 | 9.9 |
| | 21 - 30 | 54 | 15.5 |
| | | 57 | 16.3 |
| | 31 -40 | | |
| | 41 - 50 | 56 | 15.9 |
| | 51- 60 | 74 | 21.0 |
| | > 60 | 38 | 11.1 |
| No. of years in small occupation | Animal rearing | 50 | 14.3 |
| | Crop farming | 111 | 31.8 |
| | Fishing | 83 | 23.8 |
| | Fish mongering | 56 | 15.9 |
| | | 8 | 2.4 |
| | Illegal mining | | |
| | Hospitality industry | 11 | 3.2 |
| | Timber harvesting | 17 | 4.8 |
| No. of years in small occupation | Transport operation | 14 | 4.0 |
| | < 5 | 10 | 2.8 |
| | 6 - 15 | 20 | 5.8 |
| | | 31 | 8.7 |
| | 16- 25 | | |
| Educational attainment | >25 | 290 | 82.7 |
| | No. formal education | 151 | 43.3 |
| | Basic Cert. of Edu. | 93 | 26.6 |
| | Middle Sc. Cert of Edu | 56 | 16.1 |
| | Senior High Sch | 38 | 10.7 |
| | O'and 'A-Level | 8 | 2.2 |
| | Tertiary Education | 4 | 1.2 |

Gender

Gender is a key factor in the exploitation of natural resources. Strategies that aim at resource conservation need to consider the gender dynamics of the population, which is quite gender-elastic. There was a fair representation of gender in this study; males (58.6%) and females (41.4%). Although the culture of the communities enjoins males to hold in trust assets, e. g. farmlands of the families and were therefore considered the repository of the history of the communities, and the female respondents demonstrated endowment with substantial knowledge about the lake and the general basin resources. Based on this, the fair representation of gender in this study generated vital information for achieving the research goal.

Age of Respondents

The minimum age of the respondents was 18 years and formed the minority (7.1%) (Table 4.14). However, many respondents were 51 to 60 years old (16.7%) and over 60 years old (15.95%). The economically active population consists of all persons irrespective of gender, who are in an age class and offer contribution positively to the defined course (European System of National and Regional Accounts, 1995). The majority (57.6%) of the respondents were of ages between 31 and 50 years and were the most energetic and actively engaged in manual anthropogenic activities in the lake, with the tendency to negatively impact the lake. The age group 20-34 years forms the most active population in China, India, Europe and the US. On the other hand, older people, 51 years and above, were endowed with vital information that could be drawn on for effective conservation schemes.

Marital statuses of respondents

Respondents were married (60.32%), single (15.87%), divorced (7.94%), or widowed (15.87%). (Table1). The large percentage of married is significant in using

the lake resource. Hoang and Yabe (2012) reported that households with more members use more of their home labor to boost the exploitation of natural resources. Holding all other factors constant, the married raise families of larger sizes and, therefore, explore the high family labor advantage. The result is the likelihood of the lake being impacted to a greater extent than the singles. On Lake Bosomtwe, families set their traps for fish harvesting. It suggests that large family size offers some advantage at the expense of the resource itself, highlighting the concepts of 'the tragedy of the commons' by (Hardin, 1968).

Length of stay in the community

Respondents had lived in their respective communities for at least 5 years. Two hundred and seventy-nine (279), representing 80% and the majority, had lived in the lake catchment for more than 25 years (Table 1). More than 11% (11.11%) of the respondents, who were over 60 years old, had lived in the lake basin since birth and had been in their occupation, mainly farming and fishing as sources of their livelihoods, and could explain the human-driven changes and also the recovery potential of the lake. Therefore, respondents of this age class could contribute to the current state of the lake resources. According to Ajewole (2010), a direct relationship between the number of years of experience and the possibility of maintaining the status quo and remaining risk-averse exists unless the effects are well understood or are directly felt by the offenders.

Occupations of respondents

A large percentage of the respondents engaged in crop farming (31.7%), animal rearing (14.3%). Fishing (23.8%) fish are mongering (15.9%). Other anthropogenic activities in the study communities that may significantly impact the lake were timber harvesting, hospitality operation, illegal mining, and transport business operation. With the current trend of reduction in the catch, as recounted by the majority of the respondents, fishing efforts have been increased in the bid to maintain profit. It was characterized by the use of undersized nets, increased frequency of fishing, and increased fishing time. Therefore, there was also the possibility that the proportion of community members who were engaged in farming would increase. Again, the widespread occurrence in the scope of illegal mining activities and timber harvesting, particularly by chainsaw operators, in communities in the catchment may also be inevitable, as predicted by (Nyame and Grant, 2007). These may exert a significant negative effect on the lake by removing vegetation cover that causes land and soil exposure for increased lake siltation during runoff and physiological stress and metabolic during periods of high temperature.

Educational Attainment of Respondents

Generally, respondents had a low level of education. More than forty-three (43.3%) of respondents had no form of education. Although other respondents had some form of education, levels were generally low. Only 1.19 % had tertiary education, while 10.71% had been educated up to the secondary level. The educated were dominated by Basic Certificate of Education (26.58%) followed by Middle School and Tertiary Education (16.06%) (Table 1).

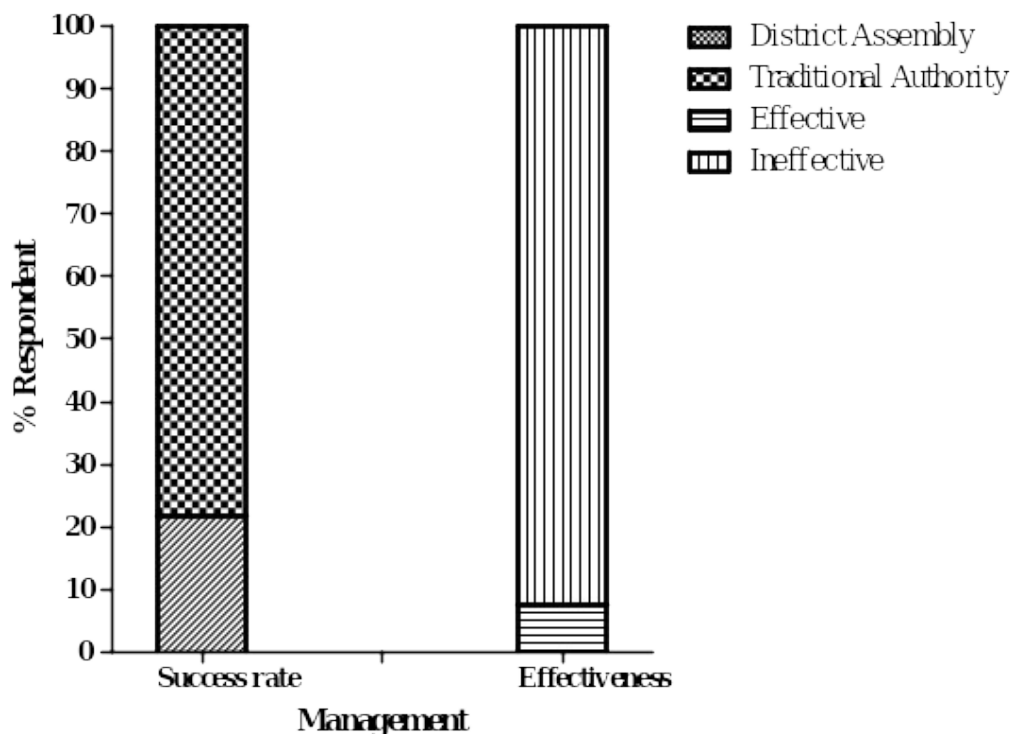
Only 13.1% and 8.6% knew of humans as a factor of general environmental degradation and water pollution, respectively. The remaining 86.9% and 81.4%, respectively, attributed the decline in fish productivity to curses from the gods. This perception might have promoted the range of environmental degradation. People's knowledge about a phenomenon is a prerequisite for the desired adjustments in their behavior paradigm (Evert et al., 2021). The relatively high proportion of uninformed people in the community may hamper understanding of the causes and effects of degradation of the lake. Education helps individuals and groups adjust to disequilibrium and the propensity to sustainably adopt innovations for resource utilization (Cruz- García and Howard, 2013; Reed and Taylor, 2007). For instance, it may be difficult for the uninformed to understand the causes and effects of some

environmental phenomena, for instance, linking the removal of fringe vegetation, temperature elevation and de-oxygenation. Abdin and Gaafar (2009) reiterated that people's attitudes are linked to education.

Managing authorities and protection practices

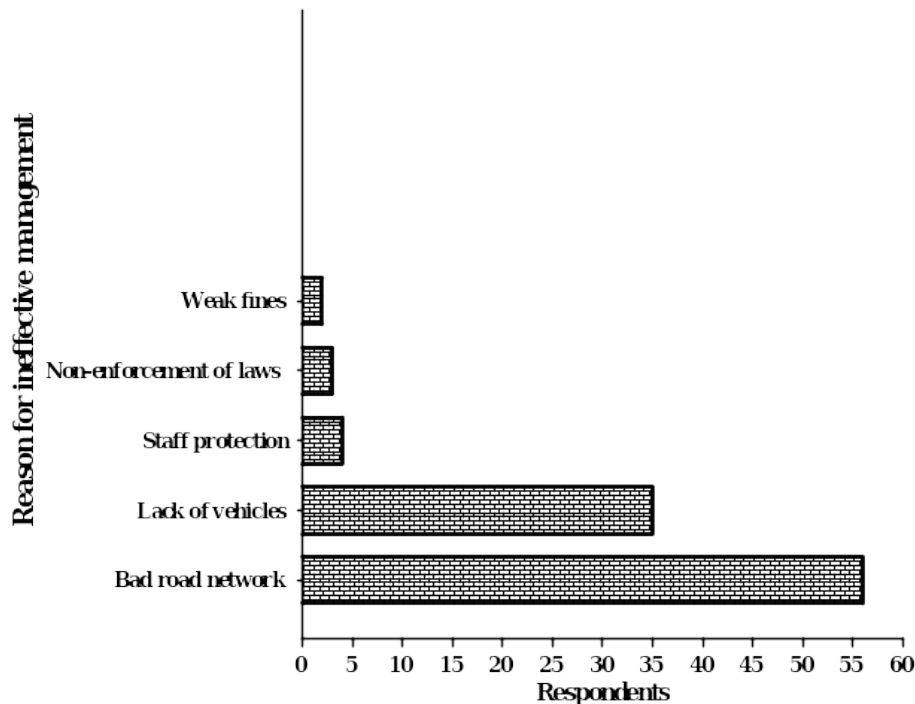
Results showed that the lake management was mainly by traditional authority, with peripheral support by the District Assembly. The majority of respondents (93.8%) indicated that the traditional systems carried out all management operations in individual communities, which were poorly coordinated. Few respondents (6.2%) noted that the District Assembly plays some role, such as periodic monitoring of the lake environment for illegal activities such as timber harvesting and illegal mining. Important elements of management, such as the drawing of the yearly program, budgeting, schedule of the visit, and warning of dangers, were lacking. There were varying views on the effectiveness of the management (Figure 3).

Figure 4. Distribution of managing authorities and practices for the protection of Lake Bosomtwe



A system of showing respect for sacred groves in forests in the communities surrounding the lake has been adopted to manage the lake and its environment. Most sacred grooves, located in the sensitive ecological areas around the lake, enjoy strict protection due to their religious, cultural and conservation importance (Kalanda-Sabola et al., 2007). These aim at curbing anthropogenic perturbations through observation of the taboo, forbidden days, and bye-laws that ban non-traditional methods of fishing in the lake (Gylfason, 2001; Heberlein, 2012; Angsongna et al., 2016). To prevent noise on the lake, motorized boats were not allowed on the lake. Transportation on the lake was by a carved plank. The effectiveness of the traditional method of managing the lake continues to decrease in recent times due to a reduction in regard for traditional beliefs (Tahirindraza, 2015; Chivasa, 2017), leading to the encroachment and at a very rapid rate. With attempts to extend this disregard of laws to the ban on motorized boats on the lake, amid rapidly growing population in the lake communities, fear of rapid degradation of the lake can be expressed.

Figure 5. Distribution of the reasons assigned for the ineffective management of Lake Bosomtwe



Officials from the District Assembly indicated a lack of logistics and motivation as the main reasons for the low participation in the lake management. The logistics mentioned included road network (56%) and availability of vehicles by which the communities can be accessed (35%). In addition, lack of protection of staff against assault (4.2 %), non-enforcement of laws (2.9%) and weak fines, which are an ineffective deterrent to violations (1.9 %) (Figure 4), are factors that de-motivate the District Assembly in protecting the lake (Ball and Bell, 1991; Downs, 2013; Faroque and South, 2020) and are the reasons for the aggravated threats to the lake.

CONCLUSION

To decrease the order of devastation, the main anthropogenic interventions in the Lake Bosomtwe basin are crop farming, fishing, fish mongering, animal rearing, timber harvesting, hospitality, washing, trading of other goods, and transportation and illegal mining. Although the inhabitants, who generally have a low level of education and environmental awareness, had generally lived and engaged in their occupation in the lake basin for many years and observed degradation, they do not appreciate human-driven degradation of the lake, but attribute it to spirituality. It has obscured the communities' contribution to the degradation of the lake, therefore debunking the possibility of unequivocal behavioral change as a possible means of solution. Furthermore, there was a subtle decline in regard for directives by the traditional authority, such as observation and avoidance of fishing and farming in taboo and forbidden periods, observation of sacred grooves, which helped control fishing efforts. These trends have to do more with ineffective policies and strategies for educating the communities of the catchment on the causes and effects of the degradation of aquatic systems and the enforcement of environmental laws. Resourcing governing authorities, including the Bosomtwe for active participation, promotion of a traditional system of protection of the lake, strict enforcement of environmental laws, Establishment of Community Resource Management Areas (CREMAs) in collaboration with other stakeholders including water resources commission, Ghana EPA, the Ghana Tourist Board Opinion Leaders and environmental NGOs are needed measure to stop degradation and promote conservation of the lake.

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